# INDOOR AIR QUALITY ASSESSMENT

**Ralph B. O'Maley Middle School**
**32 Cherry Street**
**Gloucester, Massachusetts**

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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## Background/Introduction

At the request of the Gloucester Health Department, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the O'Maley Middle School in Gloucester, Massachusetts. The request was prompted by reported complaints of odors throughout the school building.

On April 2, 2002, a visit was made to this school by Michael Feeney, Director of the Emergency Response/Indoor Air Quality Program (ER/IAQ), BEHA, to conduct an indoor air quality assessment. Mr. Feeney was accompanied by Cory Holmes, Environmental Analyst of the ER/IAQ Program and Christopher Sargent of the Gloucester Department of Health. Mr. Holmes returned on April 3, 2002 with Suzan Donahue, ER/IAQ Research Analyst, to complete the assessment. BEHA staff were accompanied by Joseph Lucido, Facilities Director for Gloucester Public Schools, and Dave Anderson, school custodian, during the April 3, 2002 visit. Mr. Feeney conducted a follow up evaluation of the gymnasium and surrounding areas at the request of the Gloucester School Department. The findings and recommendations concerning the gymnasium and vicinity will be subject to a separate report.

The school is a two-story brick building with a basement level constructed in 1973. The school is made up of a number of wings and houses grades 6-8. The second floor (third level) is primarily made up of science rooms and general classrooms. The first floor (second level) contains general classrooms, library, cafeteria, kitchen, auditorium, gymnasium and office space. Locker rooms, art rooms and general classrooms are located on the lower level.

## Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

## Results

This school has a student population of approximately 900 and a staff of approximately 120. Tests were taken during normal operations at the school and results appear in Tables 1-12.

## Discussion

### Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in sixteen out of eighty-three areas surveyed, indicating adequate ventilation in most areas of the school during the assessment. It should be indicated, however, that a large number of classrooms had open windows during the assessment, which can greatly reduce carbon dioxide levels. Of note is room 115, which had a carbon dioxide level of over 2,000 ppm with a window open, indicating a lack of air exchange in this room. Several other classrooms on the second level (rooms 203, 204, 215, 218, 220, and 226) also had elevated carbon dioxide levels with open windows and doors.

Fresh air in exterior classrooms is supplied by a unit ventilator (univent) system. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of each unit (see Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. Univents have three controls: low, high and off. Univents were found turned off in classrooms throughout the school; some due to birds nesting in close proximity to outside air intakes (see **Microbial/Moisture Concerns** section of this report). Obstructions to airflow, such as papers and books stored on univents and bookcases, carts and desks in front of univent returns were seen in a number of classrooms (see Picture 1). In order for univents to provide fresh air as designed, intakes must remain free of obstructions; importantly these units must remain "on" and allowed to operate while rooms are occupied.

Exhaust ventilation in classrooms with univents is provided by a mechanical system. The exhaust system in exterior classrooms consists of ducted, grated wall vents. Exhaust ventilation is designed to operate continuously. A number of these units were blocked by desks, trash cans and file cabinets. As with the univents, in order for exhaust ventilation to function as designed, they must be activated and remain free of obstructions.

Fresh air in interior classrooms and common areas is provided by air handling units (AHUs) located in mechanical rooms connected to ceiling-mounted air diffusers in classrooms. Air is returned to the units by ceiling-mounted grills. These units were operating during the assessment.

In order to have proper ventilation with a mechanical supply and exhaust system, these systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. According to school department officials, the date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches (see Appendix I).

Temperature readings ranged from 69° F to 75° F, which were very close to the BEHA comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. A number of temperature control/comfort complaints were expressed throughout the building. Baseboard radiators supplement the mechanical ventilation system in providing heat (see Picture 2). This equipment was found missing or broken and damaged in many areas throughout the building (see Picture 3).

In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. In addition, it is difficult to control temperature and maintain comfort without operating the ventilation equipment as designed (e.g., univents deactivated, exhaust vents obstructed). While temperature readings outside the recommended range are generally not a health concern, increased temperature can affect the relative humidity in a building.

The relative humidity in the building was within or very close to the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from forty-three to sixty-one percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of forty to sixty percent. Relative humidity outside on the day of the inspection ranged from fifty to fifty-nine percent. Relative humidity measured indoors exceeded outdoor measurements in some areas. The increase in relative humidity can indicate that the exhaust system is not operating sufficiently to remove normal indoor air pollutants (e.g., water vapor from respiration and fish tanks/aquariums). The highest humidity reading was measured in classroom 115 (61%), which contained two large fish tanks. In comparison, classroom 117 (directly next door) measured fifty-two percent, a difference of relative humidity of + 9%.

Moisture removal is important since the sensation of heat conditions increases as relative humidity increases (the relationship between temperature and relative humidity is called the heat index). As indoor temperatures rise, the addition of more relative humidity will make occupants feel hotter. If moisture is removed, the comfort of the individuals is increased. Removal of moisture from the air, however, can have some negative effects. The sensation of dryness and irritation is common in a low relative humidity environment. Relative humidity levels in the building would be expected to drop during the winter months due to heating. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

The combination of inactive ventilation systems and open exterior doors and windows can cause indoor relative humidity levels to rise. While temperature is mainly a comfort issue, relative humidity in excess of 70 percent can provide an environment for mold and fungal growth (ASHRAE, 1989). During periods of high relative humidity (late spring/summer months), windows and exterior doors should be closed to keep moisture out; in addition, AHUs, univents and exhaust ventilation should be activated to control moist air in the building.

### Microbial/Moisture Concerns

Several conditions that are directly related to design exist, that render the exterior walls of the building prone to water penetration from rainstorms. The most common design for univent installation is to place fresh air intake louvers on the surface of the exterior curtain wall. The fresh air intake louvers for univents in this building are installed *behind* the exterior wall system (see Picture 4). This configuration poses several problems, particularly in a peninsular landmass that is subject to frequent wind driven rainstorms. The presence of a flat horizontal brick plane can allow for rainwater to accumulate against the univent fresh air intake louvers and univent wall. Pooling water problems of this description are confirmed by reports of custodial staff having to mop water from classrooms during/after heavy rainstorms and the presence of lichen on the exterior brick surfaces below univent fresh air intakes (see Pictures 5 and 6). In order for lichen to grow in this manner, a substantial amount of moisture in brickwork is needed. Additional stains on exterior brickwork below univent fresh air intakes further indicate chronic moisture exposure. Water penetration in this manner can result in mold growth in building materials around univents.

The univent fresh air intake configuration also makes these vents ideal bird roosting areas. Birds and nesting materials were observed in the brick recesses in many of these univent air intakes (see Picture 7), which can allow for associated bird wastes/odors to enter classrooms via the air intake vents. Also of note is the condition of the compound used to seal the sides of univent fresh air intakes to the interior wall system. Breaches (see Picture 8) or entirely unsealed seams were noted in univents around the entire school complex. These breaches can allow for birds to penetrate into the interior of the wall system. Each univent is built into a wall mounted cabinet system. This configuration draws air from the interior of the cabinet system. Pipes connected to the univent heating coil pass into the floor through large, open holes. If these floor holes open to the sides of the fresh air louver system, the operation of the univents can draw air through the breaches and over bird roosting materials. Birds can be a source of disease. Bird wastes and feathers can contain molds, which can also be irritating to the respiratory system. Bird wastes in a building raise concerns over diseases that may be caused by exposure to bird wastes. These conditions warrant clean up of bird waste and appropriate disinfection.

Certain molds are associated with bird waste and are of particular concern for immune compromised individuals. Diseases of the respiratory tract may also result from exposure to bird waste. Exposure to bird wastes is thought to be associated with the development of hypersensitivity pneumonitis in some individuals. Psittacosis (bird fancier's disease) is another condition closely associated with exposure to bird wastes in bird raising and other occupational settings. While immune compromised individuals have an increased risk of health impacts following exposure to the materials in bird wastes, these impacts may also occur in healthy individuals exposed to these materials.

The methods to be employed in clean up of a bird waste problem depend on the amount of waste and the types of materials contaminated. The MDPH has been involved in several indoor air investigations where bird waste has accumulated within ventilation ductwork. Accumulation of bird wastes have required the clean up of such buildings by a professional cleaning contractor. In less severe cases, the cleaning of the contaminated material with a solution of sodium hypochlorite has been an effective disinfectant (CDC, 1998). Disinfection of non-porous materials can be readily accomplished with this solution. Porous materials contaminated with bird waste should be examined by a professional restoration contractor to determine if the material is salvageable. Where a porous material has been colonized with mold, it is recommended that the material be discarded (ACGIH, 1989).

The protection of both the cleaner and other occupants present in the building must be considered as part of the overall remedial plan. Where cleaning solutions are to be used, the "cleaner" is required to be trained in the use of personal protective methods and equipment (to prevent either the spread of disease from the bird wastes and/or exposure to cleaning chemicals). In addition, the method used to clean up bird waste may result in the aerosolization of particulates that can spread to occupied areas via openings (doors, etc.) or by the ventilation system. Methods to prevent the spread of bird waste particulates to occupied areas or into ventilation ducts must be employed. In these instances, the result can be similar to the spread of renovation-generated dusts and odors in occupied areas. To prevent this, the cleaner should employ the methods listed in the SMACNA Guidelines for Containment of Renovation in Occupied Buildings (SMACNA, 1995).

Another area of possible wall water penetration may be expansion joints around the exterior of the building, particularly around the exterior of the gymnasium. The exterior wall of the gymnasium contains several expansion joints (see Picture 9). A sealant compound was inserted into each joint to prevent water penetration. Expansion joint sealant was weathered, mechanically damaged or missing. (see Picture 10). Some of the expansion joints may allow for water to penetrate deep into the interior of the building. A probe was inserted approximately two feet into the expansion joint of the school and gymnasium wall (see Pictures 10 and 11). Sections of missing or damaged expansion joint sealant can serve as means for water from driving rain to penetrate into the building interior.

A number of classrooms have water-damaged ceiling tiles which can indicate leaks from either the roof or plumbing system. Water-damaged ceiling tiles can provide a source of mold and should be replaced after a water leak is discovered and repaired. Caulking around windows was crumbling/damaged throughout the building indicating that the water seal is no longer intact (see Picture 12). The library had a skylight with a broken window. Broken windows and damaged window caulking can lead to water penetration and subsequently, mold growth under certain conditions. Replacement of caulking and repairs of window leaks are necessary to prevent water penetration. Repeated water damage can result in mold colonization of window frames, curtains and items stored on windowsills. School officials reported that the Gloucester School Department has allocated funds for the replacement/repair of windows.

Several classrooms contained a number of plants. Planters with potting soil (no plants) were found in room 219. Plants, soil and drip pans can serve as sources of mold growth. Plants should also be located away from univents and exhaust ventilation to prevent aerosolization of dirt, pollen or mold. Several rooms contained aquariums with standing water (see Tables). Room 111 contained an aquarium with a number of decaying fish bodies floating at the surface (see Picture 13). When not in use, aquariums should be properly cleaned to prevent bacterial growth, mold growth and nuisance odors.

In a number of classrooms, spaces between the sink countertop and backsplash were noted (see Tables). Improper drainage or sink overflow could lead to water penetration of countertop wood, the cabinet interior and behind cabinets. Like other porous materials, if these materials become wet repeatedly they can provide a medium for mold growth.

**Other Concerns**

As discussed, the assessment was initiated due to occupant complaints of sewer gas odors in the building. The assessment occurred after a recent period of substantial rainfall following one of the driest winter seasons on record. School officials identified a number of potential pathways for sewer gas odors from dry drains. Most notably in the basement mechanical room, which houses one of the main AHUs for the building. This AHU also provides air-conditioning during warm months. AHUs that provide air-conditioning require the installation of condensation drains to prevent water build up inside the casing and ductwork. The condensation drain for this unit terminates above a floor drain that is connected to the building drainage system. Drains are usually designed with traps in order to prevent sewer odors/gases from penetrating into occupied spaces. When water enters a drain, the trap fills and forms a watertight seal. Without a periodic input of water (e.g., every other day), traps can dry, breaking the watertight seal. Without a watertight seal, odors or other material can travel up the drain and enter the occupied space. Both the floor drains and condensation drains have traps. During the heating season, AHUs do not produce condensation, which dries the traps. This AHU was found to be drawing air into the unit through the condensation drains. With each condensation drain acting as a vacuum, odors from the floor drain without a water-sealed trap can draw into the AHUs and be distributed to occupied areas in the building. This drain was capped to prevent future occurrence (see Picture 15).

School officials also reported that a rotten egg odor was reported in the general vicinity of the library shortly after the detection of sewer gas odors. BEHA staff inspected the library stairwell and found the remnants of a glass ampoule on the first floor landing against the wall (see Picture 16). Previous BEHA assessments have identified similar materials (MDPH, 2001) as “Stinkbomb Ammonium Sulfide". Ammonium sulfide solution is both a respiratory irritant and flammable material.

Flammable materials were observed on top of the flammable storage cabinet in the art room. Other materials, including other flammables, were located in front of this cabinet. Flammables should be stored in a flammable storage cabinet that meets the specifications of the NFPA (NFPA, 1996). Flammable storage cabinets should also be kept clear for easy access in case of emergency.

Complaints related to vehicle exhaust infiltration were also expressed to BEHA staff. Idling buses in the parking lot near the school can result in vehicle exhaust entrainment by the mechanical ventilation system and open windows under certain weather conditions. This may, in turn, provide opportunities for exposure to combustion products such as carbon monoxide. At the time of the assessment, no vehicle exhaust odors or measurable levels of carbon monoxide were detected within the school. M.G.L. chapter 90 section 16A prohibits the unnecessary operation of the engine of a motor vehicle for a foreseeable time in excess of five minutes (MGL, 1986).

Also of note was the amount of materials stored inside classrooms. In classrooms throughout the school, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provide a source for dusts to accumulate. These items, (e.g., papers, folders, boxes, etc.) make it difficult for custodial staff to clean. Dust can be irritating to eyes, nose and respiratory tract. Items should be relocated and/or cleaned periodically to avoid excessive dust build up. A number of exhaust and return vents in classrooms, common areas and in restrooms had accumulated dust (see Picture 17). If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize dust particles. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized, causing further irritation.

Several classrooms contained animals/pets in cages, including a guinea pig, mice, a bird, a turtle, and as mentioned previously, aquariums with fish. The birdcage contained accumulated bird wastes and seeds in and around the cage. Porous materials (i.e., wood shavings) can absorb animal wastes and can be a reservoir for mold and bacterial growth. Animal dander, fur and wastes can all be sources of respiratory irritants. Animals and animal cages should be cleaned regularly to avoid the aerosolization of allergenic materials and/or odors (NIOSH, 1998).

The main office and copy room have photocopiers. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). School personnel should ensure that local exhaust ventilation is activated while equipment is in use to help reduce excess heat and odors in these areas.

Accumulated chalk dust was noted in several classrooms. Chalk dust is a fine particulate, which can be easily aerosolized and is an eye and respiratory irritant. Several rooms had missing and/or dislodged ceiling tiles or various objects hung from the ceiling tile system. Missing/dislodged ceiling tiles can provide a pathway for the movement of drafts, dusts and particulate matter between rooms and floors. In addition, building occupants should refrain from hanging objects from ceiling tile systems throughout the school.

Several classrooms contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Boiler room odors were detected in the hallway outside of the boiler room (art wing). Spaces were observed around the boiler room door leading to the hallway. The process of combustion produces a number of pollutants, depending on the composition of the material. In general, common combustion emissions can include carbon monoxide, carbon dioxide, water vapor and smoke. Of these materials, carbon monoxide can produce immediate, acute health effects upon exposure. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm taken 20 minutes after resurfacing within the rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997). No measurable levels of carbon monoxide were detected in the building during the assessment.

In a phone conversation subsequent to the MDPH assessment, school officials reported that utility holes above the ceiling tiles adjacent to the boiler room and boiler room odors were noted in the area. These holes were sealed to prevent further odor penetration into occupied areas. In addition, a contractor was reportedly hired to clean the chimney flue of accumulated debris. Reportedly these actions have alleviated odor complaints. School officials also reported that they are in the process of purchasing digital readout carbon monoxide detectors.

Although lighting was not reported as an issue in the building, improper lighting can have an effect on the comfort of individuals in a building leading to complaints such as headaches, nausea, visual fatigue and eye strain. Insufficient lighting can also effect the ability to concentrate and reduce work performance (NSC, 1996). Lighting fixtures throughout the building were at half capacity (see Picture 18). It was reported by school officials that ballasts in each lighting unit were removed as an energy conservation measure during the late 1970's early 1980's.

A number of current/former science classrooms are equipped with freestanding sinks, which appear to be used infrequently. Building occupants in this area reported odors from the drains. Sinks are equipped with drain traps that form a water seal to prevent the backup of sewer odors. Without water, the airtight seal on the trap can be breached; resulting in sewer gas backing up the drains and entering occupied areas. Sewer gas can create nuisance odors and be irritating to certain individuals. BEHA staff noted unpleasant odors from the sink in 315; the trap was inspected and was found clogged with debris preventing drainage, allowing water in the drain to stagnate.

Concerns about a dried material on the wall of the science prep room (315) were expressed to BEHA staff. It was reported that the material had leaked into the building and down the wall as a result of the installation of a new roof in 1989. BEHA staff closely examined the material, which was dry and odorless at the time of the assessment. Exposure to VOCs can be associated with the usage of these types of materials. Due to the age and condition of the material on the wall in prep room 315, it would appear that any likely irritation due to exposure would have occurred at the time of application, before the material was cured.

## Conclusions/Recommendations

The solution to the indoor air quality problem at the O'Malley Middle School is somewhat complex. The combination of the general building conditions, maintenance, design and the operation (or lack) of HVAC equipment, if considered individually, present conditions that could degrade indoor air quality. When combined, these conditions can serve to further negatively affect indoor air quality. Some of these conditions can be remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and equipment. For these reasons a two-phase approach is required, consisting of **short-term** measures to improve air quality and **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns.

The following **short-term** measures should be considered for immediate implementation:

1. Continue to seal the floor drain in the mechanical room during the heating season or ensure water is poured into the drains every other day to maintain the integrity of the traps.
2. Seal the condensation drains for AHUs during the heating season. Please note that these drains must be unsealed during the air-conditioning season in odor to drain condensation. Failure to remove condensation drain seals can result in water back up into AHUs and the potential for mold growth.
3. Clean interior and exterior or univents completely of bird wastes in accordance with CDC health and safety practices before-reactivating univents. To prevent further bird roosting, consider installing bird screens to the *outside* of brick openings.
4. Examine all expansion joint seals on the exterior wall system. Reseal all expansion joints with damaged, missing or eroded sealant.
5. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.

6. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Operate univents while classrooms are occupied. To increase airflow, set univent controls to "high". Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers school-wide.
7. Inspect exhaust motors and belts for proper function, repair and replace as necessary.
8. Remove all blockages from univents and exhaust vents.
9. Consider having the systems re-balanced every five years by an HVAC engineering firm.
10. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
11. Replace/repair any remaining water-stained ceiling tiles and building materials. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
12. Move plants away from univents in classrooms. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.
13. Continue with plans to repair/replace window systems.
14. Clean and maintain aquariums and terrariums to prevent bacterial/mold growth. Remove decaying fish from aquarium in classroom 111.
15. Ensure all plants are equipped with drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary. Consider reducing the number of plants.

16. Seal areas around sinks to prevent water-damage to the interior of cabinets and adjacent wallboard. Inspect wallboard for water-damage and mold/mildew growth, repair/replace as necessary. Disinfect areas of microbial growth with an appropriate antimicrobial as needed.
17. Remove clog and flush drain in classroom 315. If not in use, seal drains or pour water down regularly to prevent sewer gas back up.
18. Store cleaning products properly and out of reach of students. Store flammables in a flameproof cabinet.
19. Replace missing ceiling tiles, to prevent the egress of dirt, dust and particulate matter into classrooms. Refrain from hanging objects from ceiling tile system.
20. Have a chemical inventory done in all storage areas and classrooms. Properly store flammable materials in a manner consistent with the local fire code. Discard hazardous materials or empty containers of hazardous materials in a manner consistent with environmental statutes and regulations. Label chemical containers with the chemical name of its contents. Follow proper procedures for storing and securing hazardous materials.
21. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
22. Obtain Material Safety Data Sheets (MSDS) for chemicals from manufacturers or suppliers. Maintain these MSDS' and train individuals in the proper use, storage and protective measures for each material in a manner consistent with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL, 1983).
23. Clean chalkboards and trays regularly to avoid the build-up of excessive chalk dust.
24. Clean and disinfect walls of the 315 prep room and any other areas coated with dried roofing material.

25. Seal boiler room door with weather-stripping material and ensure all utility holes, wall cracks and any other possible pathways are sealed to prevent the egress of boiler room/fuel odors into occupied areas. It may be helpful to turn off all lights and examine adjacent walls for light penetration and/or drafts.

26. Relocate student drop off area or consider posting signs instructing drivers to shut off engines after five minutes as required by Massachusetts General Laws 90:16A. If not feasible, consider installing a timer to deactivate univent in nurse's area prior to student pick up, as suggested by Mr. Lucido.

The following **long-term measures** should be considered:

1. Examine the seal around each univent fresh air intake louver grille for sealant integrity. Reseal each joint to prevent air bypass.
2. Seal all pipe holes within univents.
3. To prevent water penetration in/around univents consider installing an awning type structure to prevent penetration from wind driven rain. Pictures 19 and 20 depict a style of fresh air intake used to shield the fresh air intakes at the King Phillip Regional High School in Wrentham, MA. The shield should have flashing installed to direct rainwater from the exterior wall system (see Figure 2).
4. Replace/repair missing/damaged radiator baseboard diffusers throughout the school.

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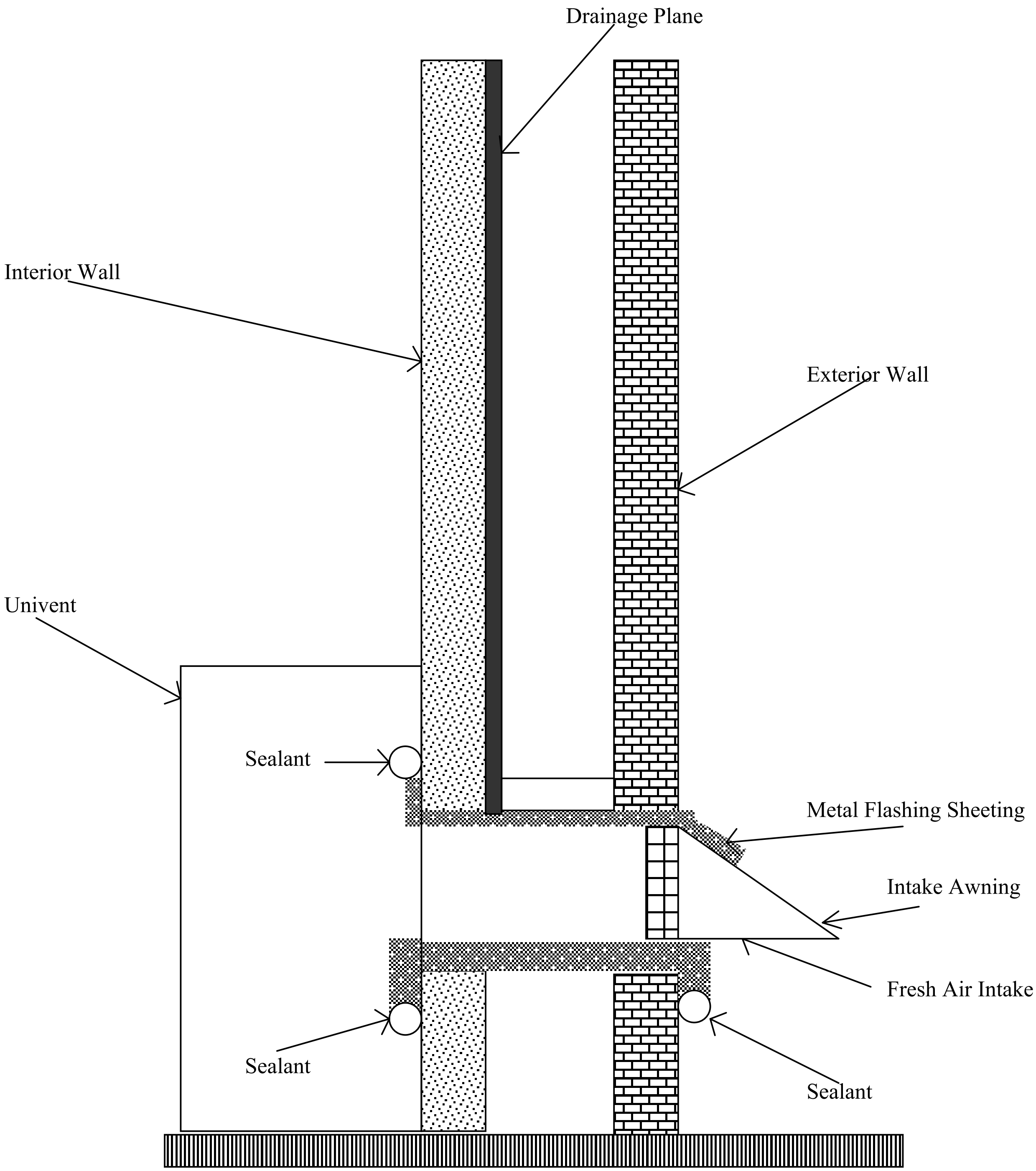
**Figure 2**
**Protection of Univent Fresh Air Intake Vent Using A Metal Awning Shield from Driving Rain**



**Picture 1**


**Classroom Univent Obstructed By Various Items**

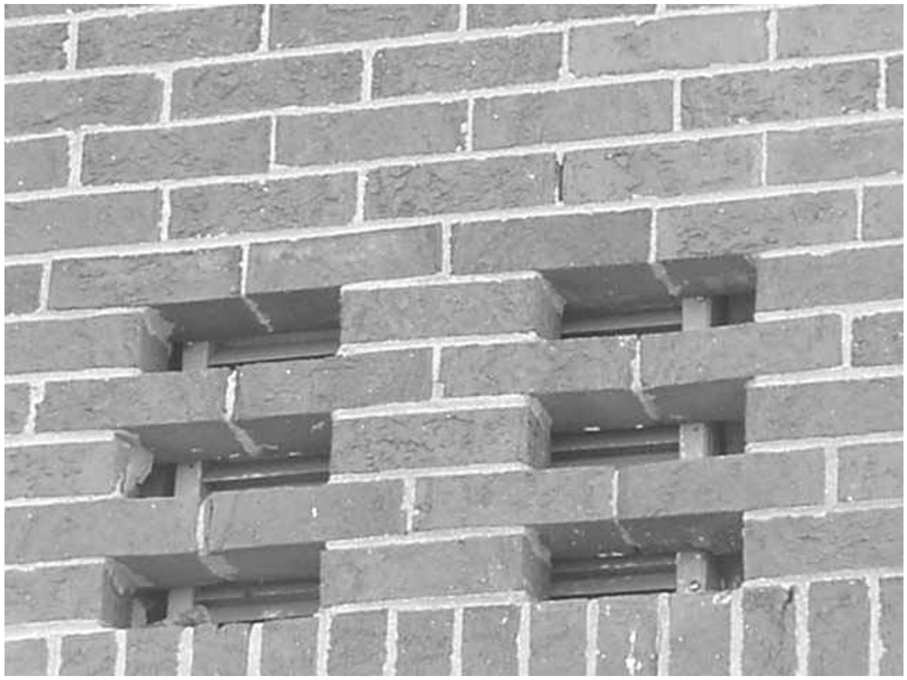
**Picture 2**

**Baseboard Radiator in Classroom**

**Picture 3**

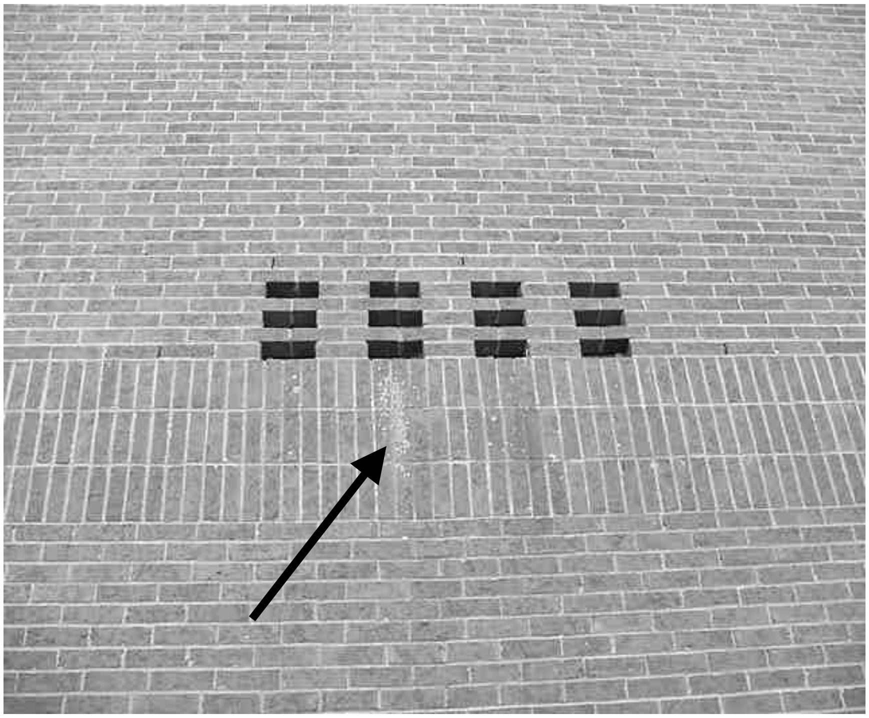
**Damaged Classroom Baseboard Radiator (This Was Observed in a Large Number of Areas)**

**Picture 4**



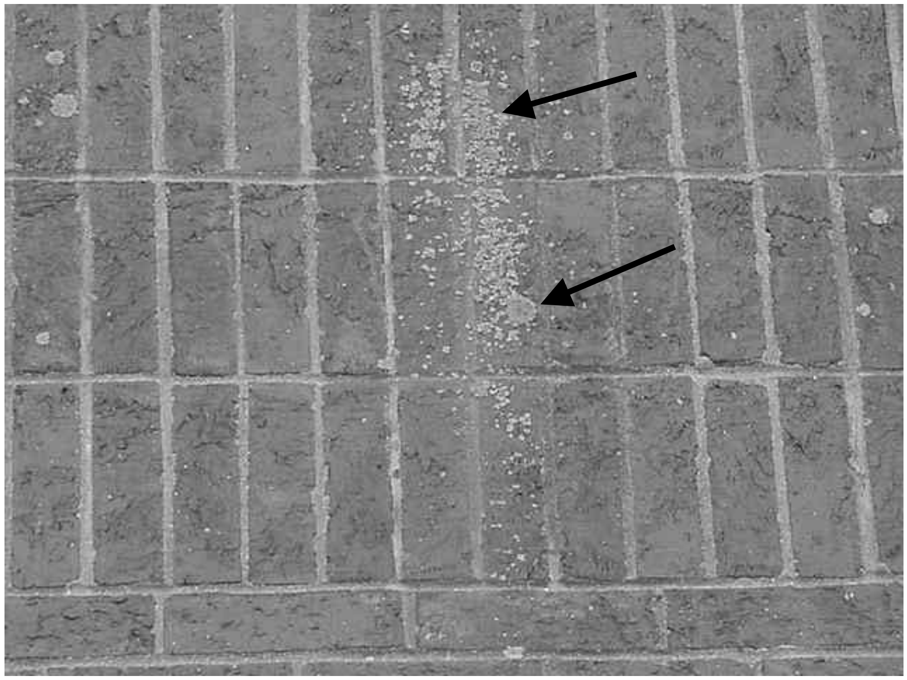
**Fresh Air Intake Installed Inside the Exterior Wall**

**Picture 5**



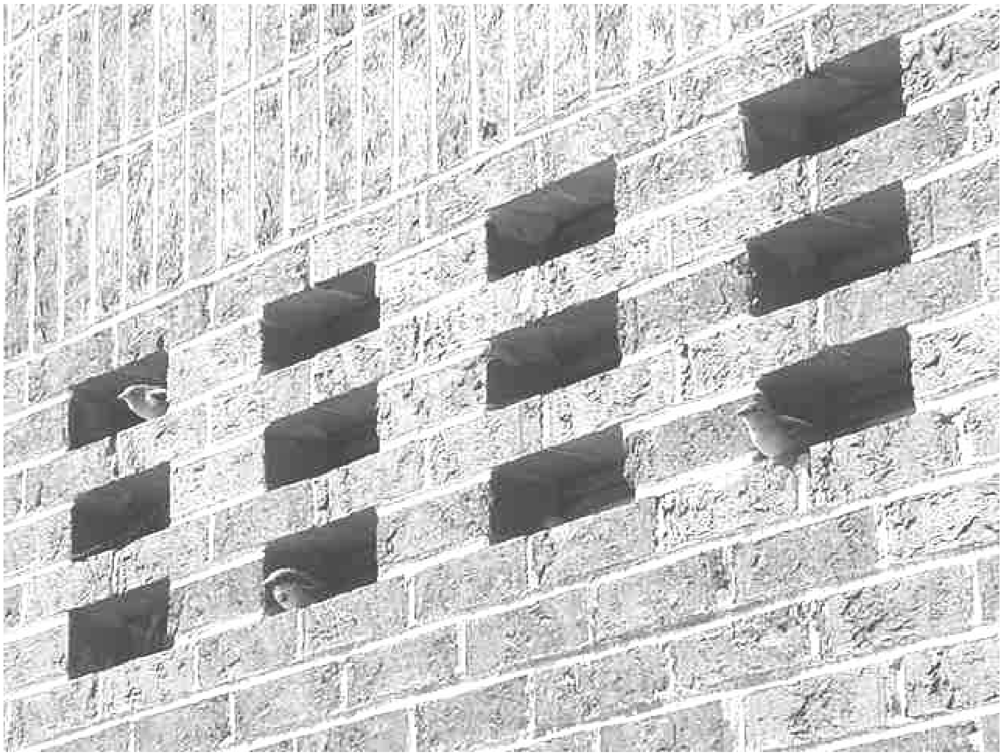
**Water Damage and Lichen Growth below Fresh Air Intake, Indicating Unusual Water Exposure to Brick**

**Picture 6**



**Close Up Of Water Damaged Brick, Note Lichen**

**Picture 7**



**Birds Nesting In Brickwork/Univent Air Intakes**

**Picture 8**

**Degraded Expansion Joint Sealant, Gymnasium Wall, Probe Inserted Into Space**

**Picture 9**

**Gymnasium Expansion Joint**

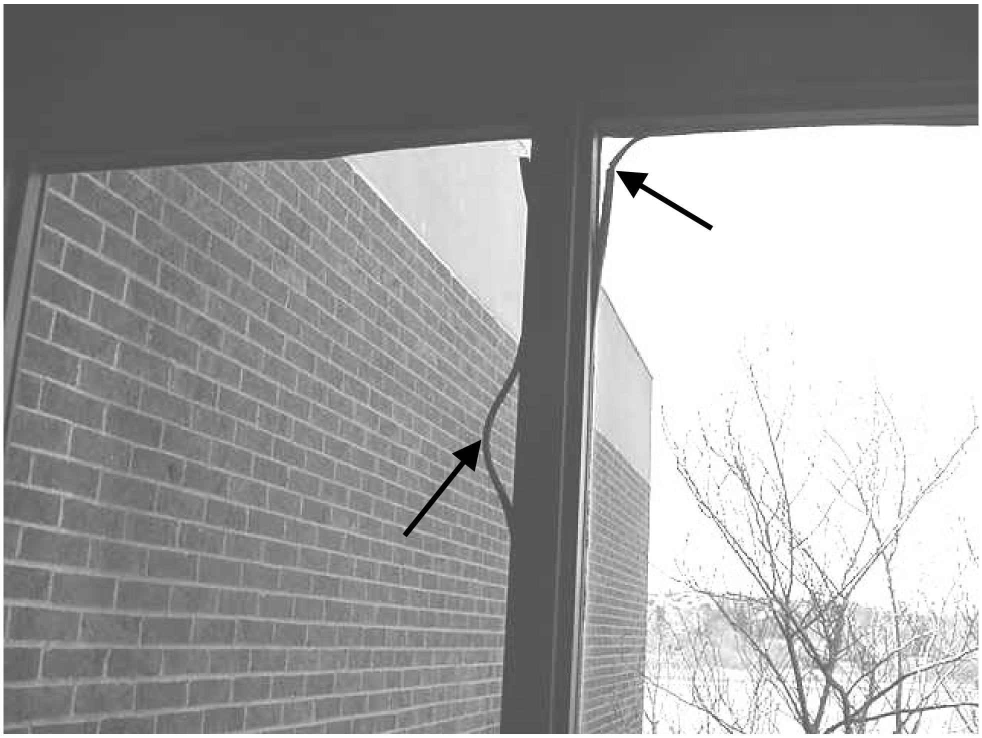
**Picture 10**

**Length of Probe Inserted Into Expansion Joint Sealant**

**Picture 11**

**Space In Gymnasium Wall Joint, Note Length of Probe**

**Picture 12**

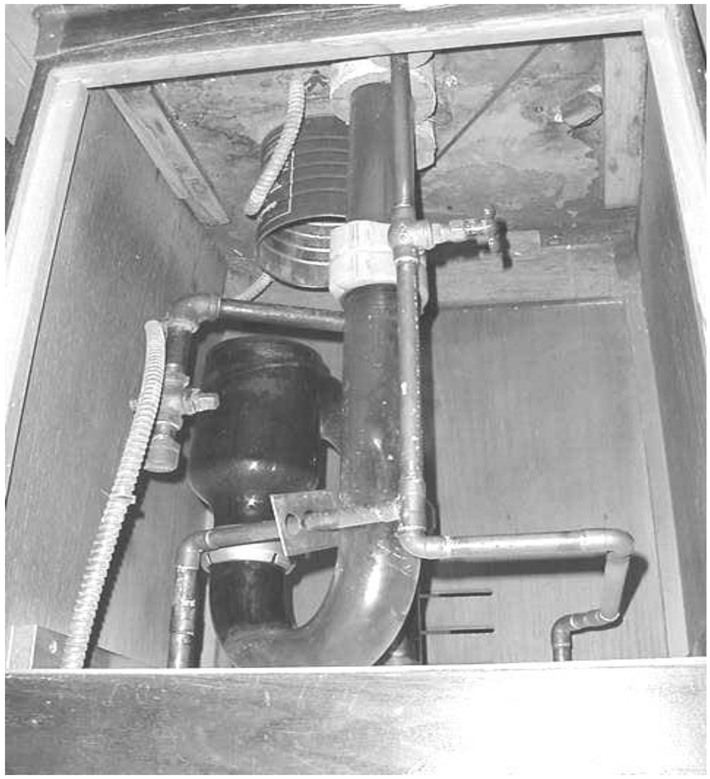


**Failing Window Caulking**

**Picture 13**

**Decaying Fish Bodies Floating In Classroom 111 Aquarium**

**Picture 14**

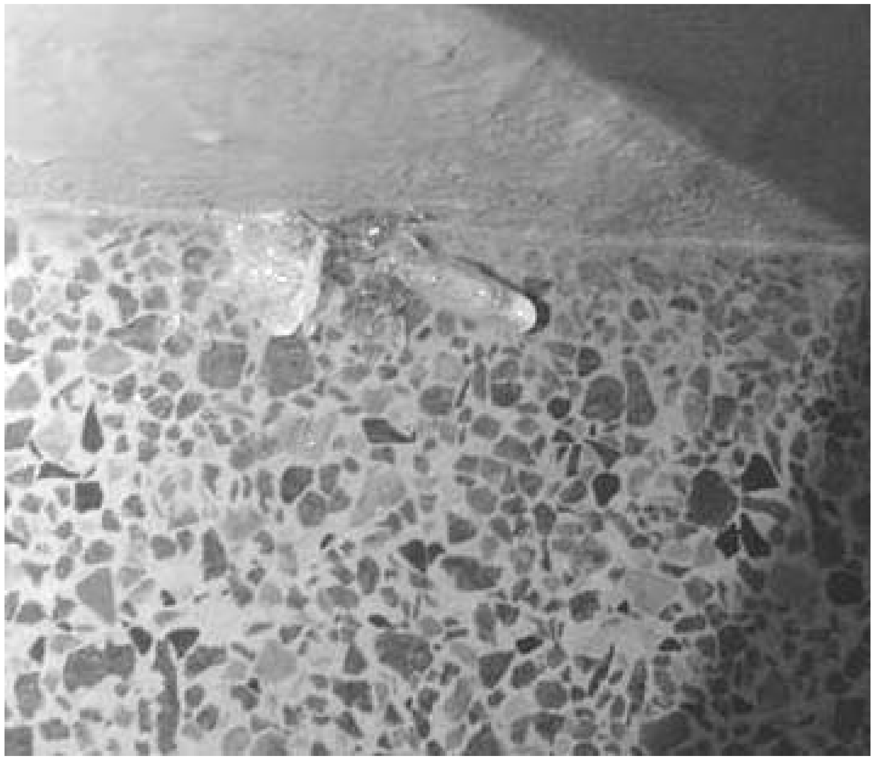


**Drain Clogged with Debris in Science Classroom 315**

**Picture 15**

**Condensation Drain Pipe From AHU and Sealed Drain in Mechanical Room**

**Picture 16**



**Broken Glass from Ammonium Sulfide Ampoule**

**Picture 17**

**Close-Up of Accumulated Dust Build-Up on Exhaust Vent**

**Picture 18**

**Typical Lighting Fixture in Classroom Note Only One of Two Fluorescent Bulbs Installed**

**Picture 19**

**Fresh Air Intake Awning/Shield Recommended For Installation Over Fresh Air Intakes**
**(Picture Taken at King Phillip Regional High School, Wrentham, MA)**

**Picture 20**

**Fresh Air Intake Awning/Shield Recommended For Installation Over Fresh Air Intakes**
**(Picture Taken at King Phillip Regional High School, Wrentham, MA)**

**TABLE 1**

## Indoor Air Test Results – O'Malley Middle School, Gloucester, MA – April 3, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Outside (Background) | 369 | 63 | 59 | | | | | |
| Chorus Room | 810 | 70 | 53 | 15 | No | Yes | Yes | Exhaust weak/off, flickering lights, chalk dust |
| Room 226 | 1006 | 69 | 53 | 17 | Yes | | | Window open |
| Staff Room | 696 | 73 | 50 | 0 | No | Yes | Yes | Water-damaged CT |
| Room 122 | 688 | 74 | 49 | 4 | No | Yes | Yes | Exhaust off, CT ajar, 3 computers |
| Room 121 | 697 | 73 | 48 | 0 | No | Yes | Yes | Exhaust off |
| Room 120 | 643 | 73 | 50 | 1 | Yes | Yes | Yes | Univent and exhaust off, window and door open, aquarium-turtle |
| Castro/McLean Office | 632 | 74 | 49 | 0 | No | Yes | Yes | Water-damaged CT, missing CT, door open, cracked tiles |
| Room 118 | 680 | 72 | 50 | 0 | Yes | Yes | Yes | Door open, chalk dust, reported puddles |
| Room 116 | 757 | 73 | 51 | 1 | Yes | Yes | Yes | Window and door open, univent off, chalk dust, damaged/missing window caulking` |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 2**

## Indoor Air Test Results – O'Malley Middle School, Gloucester, MA – April 3, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Room 112 | 643 | 73 | 49 | 0 | No | Yes | Yes | Chalk dust, door open |
| Room 124 | 960 | 73 | 48 | 1 | No | Yes | Yes | Exhaust off, 3 plants, chalk dust |
| 124 Inner | 766 | 74 | 48 | 1 | No | Yes | Yes | Paper in univent louvers, door open |
| Room 126 | 578 | 72 | 47 | 0 | No | Yes | Yes | Dry erase board |
| 126 Storeroom | | | | | No | Yes | Yes | Dry erase board cleaner, cleaning product |
| Room 218.6 | 739 | 75 | 46 | 1 | No | Yes | Yes | Dry erase board & cleaner, accumulated items, door open |
| Room 218 | 948 | 74 | 47 | 21 | Yes | Yes | Yes | Window open, accumulated items, personal fan, wall-mounted exhaust vent near open door |
| Room 216 | 652 | 72 | 48 | 1 | Yes | Yes | Yes | Window and door open, ~30 occupants gone 5 mins. |
| Room 212 | 715 | 73 | 50 | 7 | No | Yes | Yes | Water-damaged CT, dry erase board |
| Room 202 | 699 | 74 | 44 | 2 | Yes | Yes | Yes | Univent off-heat only, window open |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 3**

## Indoor Air Test Results – O'Malley Middle School, Gloucester, MA – April 3, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Room 204 | 838 | 75 | 46 | 0 | Yes | Yes | | Window open |
| Room 206 | 771 | 75 | 46 | 16 | Yes | Yes | Yes | Window open, items on univent, accumulated items, plant |
| Library | 562 | 73 | 46 | ~30 | No | Yes | Yes | Carpet, broken window, ~12 plants |
| Room 106 | 539 | 72 | 52 | 0 | Yes | Yes | Yes | Window open, univent off, 4 water-damaged CT, CT ajar, accumulated items, aquariums, mice, plants, chalk dust, cleaning product |
| Room 104 | 541 | 71 | 51 | 0 | Yes | Yes | Yes | Window open, chalk dust, personal fan |
| Giuliano/Wakman Office | 626 | 72 | 51 | 0 | No | Yes | | 2 missing CT, personal fan |
| Room 102 | | | | 1 | Yes | Yes | Yes | Window open, ~20 occupants gone <30 mins., chalk dust, tennis balls |
| Balcony/Computer Area | 752 | 73 | 49 | 0 | No | | | 10 computers |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 4**

## Indoor Air Test Results – O'Malley Middle School, Gloucester, MA – April 3, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation Intake | Ventilation Exhaust | Remarks |
|---|---|---|---|---|---|---|---|---|
| Main Office | 648 | 73 | 48 | 1 | No | Yes | Yes | 2 ceiling-mounted supply vents-1 covered with cardboard, 5 plants, door open |
| Room 222 | 637 | 73 | 47 | 8 | No | Yes | Yes | Spaces around sink/countertop, 2 water-damaged CT, dry erase board |
| 222 Storage Area | | | | | | | Yes | 3 missing CT, refrigerator, electric box |
| 222 Lab Area | 588 | 74 | 47 | 2 | No | Yes | Yes | Air purifier, door open, refrigerator |
| Room 226 | 529 | 69 | 46 | 0 | Yes | Yes | Yes | Supply and exhaust off, window and door open, accumulated items, personal fan |
| Ziergiebel Office | 652 | 71 | 51 | 0 | Yes | Yes | Yes | Window and door open, humidifier, cleaning products |
| Martin Office | 643 | 73 | 49 | 1 | Yes | Yes | Yes | 6 water-damaged CT |
| Dwinell Office | 638 | 73 | 48 | 1 | Yes | Yes | Yes | Window open, accumulated items, dry erase board |
| 2nd Floor Restroom | | | | | | | Yes | Exhaust weak, door open |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

TABLE 5

## Indoor Air Test Results – O'Malley Middle School, Gloucester, MA – April 3, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation Intake | Ventilation Exhaust | Remarks |
|---|---|---|---|---|---|---|---|---|
| Copy Room | 720 | 74 | 47 | 2 | No | Yes | Yes | 4 photocopiers, door open |
| Room 220 | 955 | 75 | 47 | 22 | Yes | Yes | Yes | Window and door open, dry erase board, cleaning product, chalk dust, accumulated items, tennis balls |
| Teachers' Lounge | 539 | 71 | 50 | 0 | Yes | Yes | Yes | Window open, exhaust in restrooms (2)-on, 1 water-damaged CT, upholstered furniture-stains |
| Room 302 | 591 | 73 | 48 | 0 | Yes | Yes | Yes | Window and door open, chalk dust, dry erase board, 3 cracked CT, 2 plants, 2 sinks-spaces around countertop |
| Mechanical Room/Teacher's Room off 302 | | | | | | | | 5 water-damaged CT, carpet, exposed fiberglass, ladder access to roof, door open |
| Room 304 | 631 | 74 | 43 | 0 | Yes | Yes | Yes | Univent and exhaust off, 1 water-stained CT, 2 missing CT, 3 plants, window open |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 6**

## Indoor Air Test Results – O'Malley Middle School, Gloucester, MA – April 3, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Back Room off 304 | | | | | | | | Former darkroom, plate maker, plastic over sink drain, darkroom wastes under sink |
| Hussey Office | 1232 | 75 | 45 | 1 | No | Yes | Yes | Accumulated items |
| Reading Room | 630 | 75 | 44 | 0 | No | Yes | No | |
| Room 308 | 814 | 74 | 46 | 19 | No | Yes | Yes | Exhaust weak/off, 4 water-damaged CT, 3 missing CT, 2 holes in CT, chalk dust, door open |
| 308/314 Prep-room | | | | | No | Yes | Yes | Exhaust off, 4 missing CT, 7+ water-damaged CT, sink |
| Room 314 | 727 | 73 | 47 | 1 | No | Yes | Yes | Exhaust weak/off, 3 CT ajar, capped gas-valve in wall hole, personal fan, dry erase board, chalk dust, door open |
| Room 310 | 804 | 73 | 48 | 20 | Yes | Yes | Yes | Door open, dry erase board, CT ajar, water-damaged CT, 5 plants, water-damaged/missing window caulking |
| Room 312 | 584 | 72 | 46 | 1 | Yes | Yes | Yes | Window and door open, exhaust weak/off, chalk dust |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

TABLE 7

## Indoor Air Test Results – O'Malley Middle School, Gloucester, MA – April 3, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation Intake | Ventilation Exhaust | Remarks |
|---|---|---|---|---|---|---|---|---|
| 312 Prep-room | | | | | | Yes | Yes | Door open, sink, microwave, lights |
| Room 129 (Art) | 481 | 72 | 50 | 20 | No | Yes | Yes | Missing CT, aquarium-standing water, exhaust vent obstructed by items on lighting fixtures, exterior door open, pool with running water |
| Room B-128 (Art) | 605 | 73 | 49 | 21 | No | Yes | Yes | Missing CT |
| Art Storeroom | | | | | No | No | No | Flammable materials *ON* flammables cabinet, materials not sealed properly, off-gassing in cabinet, spilt materials, odor complaints, materials obstructing access to flammables cabinet |
| Room 211 | 720 | 75 | 50 | 22 | No | Yes | Yes | Complaints-temperature/humidity issues, reported water leak @ wall panel-not frequent-dry (moisture testing done), storeroom |
| Nurse's Office | 612 | 75 | 48 | 2 | Yes | Yes | Yes | Window open, univent off, vehicle exhaust complaints |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 8**

## Indoor Air Test Results – O'Malley Middle School, Gloucester, MA – April 3, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Background-Outside | 424 | 65 | 50 | | | | | 1:20 pm |
| Room 301 | 570 | 71 | 54 | 0 | Yes | Yes | Yes | Dust accumulation on vents, door open |
| Reading Lab | 575 | 74 | 49 | 0 | No | Yes | Yes | |
| Hussey Office | 801 | 75 | 48 | 1 | No | Yes | Yes | Door open |
| Room 307 | 768 | 73 | 46 | ~20 | Yes | Yes | Yes | Window open, univent off, plants, water-damaged CT in hallway outside classroom, birds nesting outside air intake |
| Room 315 | 690 | 70 | 47 | 0 | Yes | Yes | Yes | Window and door open, univent off-items in front of return, missing CT, terrarium with decaying leaves in front of return, plants |
| 315 Prep-room | | | | | | | | 4 water-damaged CT, stains on wall-from rubber roof-no odor, 2 missing CT, abandoned aquariums |
| Lexmark Closet | 544 | 72 | 44 | 0 | No | No | Yes | Missing/water-damaged CT |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 9**

## Indoor Air Test Results – O'Malley Middle School, Gloucester, MA – April 3, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Music/Chorus Room | 436 | 69 | 52 | 1 | No | Yes | Yes | Sewer gas odors, water-damaged CT in corner, flickering lights |
| Auditorium | 627 | 74 | 45 | 17 | No | Yes | Yes | |
| Ziergiebel Office | 660 | 74 | 46 | 0 | Yes | Yes | Yes | Window and door open, 4 water-damaged CT, humidifier |
| Room 223 | 670 | 74 | 46 | 16 | No | Yes | Yes | 1Water-damaged CT, 1 broken CT |
| Room 201 | 1405 | 75 | 48 | 24 | Yes | Yes | Yes | Univent off, door open |
| Room 203 | 1185 | 73 | 49 | 21 | Yes | Yes | Yes | Window open, occupant doesn't operate univent |
| Room 205 | 1120 | 74 | 48 | 17 | Yes | Yes | Yes | Univent off |
| Room 207 | 784 | 74 | 48 | 17 | Yes | Yes | Yes | |
| Room 209 | 683 | 74 | 48 | 21 | No | Yes | Yes | CT ajar, heat complaints |
| Parker Office | 589 | 74 | 46 | 1 | No | Yes | Yes | Aquarium |
| Library | 420 | 74 | 48 | ~10 | No | Yes | Yes | Broken panes in skylight |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

TABLE 10

## Indoor Air Test Results – O'Malley Middle School, Gloucester, MA – April 3, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Library Office | 447 | 73 | 47 | 0 | No | Yes | Yes | 3 water-damaged CT |
| Room 212 | 723 | 75 | 49 | 20 | No | Yes | Yes | 1 water-damaged CT, door open |
| Room 217 | 546 | 73 | 49 | 20 | Yes | Yes | Yes | Window open, supplemental ventilation |
| Room 215 | 980 | 74 | 49 | 18 | Yes | Yes | Yes | Window open |
| Room 219 | 760 | 72 | 49 | 18 | Yes | Yes | Yes | Window and door open, planters with potting soil-no plants |
| Room 111 | 682 | 73 | 51 | 20 | Yes | Yes | Yes | Abandoned aquarium-10+ dead fish floating in tank, 2 water-damaged CT, bird cage-seed and debris over cart, door open, cleaning product-"Tire Wet" |
| Room 119 | 687 | 72 | 52 | 22 | Yes | Yes | Yes | Window and door open, plants |
| Room 117 | 560 | 70 | 52 | 21 | Yes | Yes | Yes | Window open, exhaust vent blocked by trash can |
| Room 115 | 2427 | 74 | 61 | 23 | Yes | Yes | Yes | 2 large fish tanks, guinea pig, higher humidity |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

TABLE 11

## Indoor Air Test Results – O'Malley Middle School, Gloucester, MA – April 3, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Computer/All-Purpose Room | 403 | 69 | 53 | 3 | Yes | Yes | Yes | Window open |
| Room A137 | 440 | 71 | 54 | 0 | No | Yes | Yes | 10 water-damaged CT, ~25 computers, heat complaints |
| ESL Room | 456 | 70 | 53 | 3 | No | Yes | Yes | 6 missing CT, door open |
| Prouty Office | 494 | 70 | 53 | 4 | No | Yes | Yes | |
| Room 105 | 458 | 70 | 56 | 0 | Yes | Yes | Yes | Accumulated items, window open |
| Room 103 | 886 | 72 | 53 | 1 | Yes | Yes | Yes | |
| Room 101 | 609 | 73 | 53 | 1 | Yes | Yes | Yes | Univent off, window open, 2 water-damaged CT, terrarium, exhaust partially blocked, abandoned aquarium, 17 occupants recently gone |
| Room 107 | 584 | 74 | 51 | 0 | Yes | Yes | Yes | Door open |
| Room 109 | 600 | 73 | 50 | 0 | Yes | Yes | Yes | Missing CT, door open |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 12**

## Indoor Air Test Results – O'Malley Middle School, Gloucester, MA – April 3, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation Intake | Ventilation Exhaust | Remarks |
|---|---|---|---|---|---|---|---|---|
| Art Room 130 | 531 | 75 | 47 | 18 | No | Yes | Yes | Exhaust on-louvers closed |
| Boiler/Mechanical Room | | | | | | | | Drains sealed/capped-some dried out/drought |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |